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ORIGINAL ARTICLE

Rediscovery of *Microgecko helenae fasciatus* (Schmidtler and Schmidtler, 1972) from Kermanshah Province, Western Iran with Notes on Taxonomy, Morphology, and Habitat

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Abstract During extensive field work in the Zagros Mountains, western Iran, from October 2013 to November 2014, twenty five localities in different areas of the Kermanshah Province were investigated. Nineteen specimens of Schmidtler's dwarf gecko, *Microgecko helenae fasciatus*, were collected from six localities in western and southeastern regions of the Kermanshah Province. This new collection verifies the presence of *M. h. fasciatus* in the area after the description of Schmidtler and Schmidtler of the holotype specimen in 1972. All of the collected specimens are consistent with the described specimens in diagnostic characters, as have a uniform dorsal pattern with five distinct dark crossbars and white posterior margins as well as the higher number of dorsal scales between axilla and groin. Detailed morphology of the new specimens is discussed and compared with those of rare previous records. Taxonomy, distribution, and habitat types of this tiny gecko in the western foothills of the Zagros Mountains are also discussed.

Keywords Gekkonidae, banded dwarf gecko, *Microgecko helenae fasciatus*, Zagros Mountains, Iran

1. Introduction

The dwarf geckos of the newly revived genus *Microgecko* Nikolsky, 1907 encompass four species distributed in Iran, Pakistan and India (Agarwal, 2009; Bauer *et al*., 2013). Iran hosts three species of the genus including: *Microgecko helenae* with two endemic subspecies; the endemic species, *M. latifi*, and *M. persicus*, with two subspecies (Anderson, 1999; Bauer *et al*., 2013; Gholamifard, 2011; Minton *et al*., 1970; Rastegar-Pouyani *et al*., 2008; Šmíd *et al*., 2014). Until recently all populations of the Iranian dwarf geckos were categorized within the genus *Tropiocolotes* by many authors (e.g., Anderson, 1999; Karamiani and Rastegar-Pouyani, 2012; Leviton *et al*., 1992; Leviton and Anderson, 1972; Minton *et al*., 1970; Rajabizadeh *et al*., 2010; Rastegar-Pouyani *et al*., 2008; Schmidtler and Schmidtler, 1972; Szczerbak and Golubev, 1996; Torki *et al*., 2008, and others). Here, we follow Bauer *et al*. (2013) and Pyron *et al*. (2013) in assigning all of the previously considered *Tropiocolotes* geckos of Iran to the genus *Microgecko* with the exception of *Tropiocolotes* cf. *steudneri* and a newly described species, *T. naybandensis* Krause *et al*. (2013).

The banded dwarf gecko, *Microgecko helenae* is the type species of the genus. It was first described from Alchorschir (Alkhorshir), Aguljaschker, Isfagan, and Bidezar in Khuzestan Province, southwestern Iran (Anderson, 1999), restricted to Bidezar (= Bid Zard) in Khuzestan Province by Schmidtler and Schmidtler (1972). *Microgecko helenae fasciatus* (Schmidtler and Schmidtler, 1972) originally was described as *Tropiocolotes helenae fasciatus* based only on the holotype (ZSM 501/68) from Sorkheh Dizeh ("Dize") [also noted as "Sorkh-e-Dize" in the original description], 125 km west of Kermanshah,

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on road to Qasr-e Shirin (on road to Baghdad as given in the original description), Kermanshah Province, and three paratypes (ZSM 400/1970/1-3; given as ZSM 400/70 in the original description), from 25 km west of Khorramabad, on road to Ahwaz, Lorestan ("Luristan") Province. The Khuzestan dwarf gecko, *M. h. helenae* has been recorded from numerous localities along the Zagros Mountains (Anderson, 1999; Frynta *et al*., 1997; Gholamifard and Rastegar-Pouyani, 2015; Krause *et al*., 2013; Minton *et al*., 1970; Rastegar-Pouyani *et al*., 2007; Schmidtler and Schmidtler, 1972; Šmíd *et al*., 2014; Szczerbak and Golubev, 1996; Tuck, 1971, and others), Schmidtlers' dwarf gecko, *M. h. fasciatus* has only been recorded from two localities on the western slopes of the Zagros Mountains in Kermanshah and Lorestan Provinces (Schmidtler and Schmidtler, 1972). Torki (2007) also recorded additional specimens of this gecko from the paratype locality in Lorestan Province. In this study, based on the new collection, we record *M. h. fasciatus* from several localities in Kermanshah Province about 40 years after the description of the holotype specimen and extend the distributional range of this gecko to Ilam Province. The other aim of this study is to investigate the taxonomy, morphology, distribution, and habitat of this lovely tiny gecko in Iran based on the present and previous results.

2. Materials and Methods

2.1 Study area Kermanshah Province spreads over an area of about 25 000 km^2 (1.5% of total area of Iran) and is located between latitudes 33.7° and 35.3°N and longitudes 45.5° and 48°E, on the western periphery of the Iranian Plateau. The region is bordered to the north by Kurdistan Province, to the south by Ilam and Lorestan Provinces, to the east by Hamedan Province, and to the west by Iraq (Figure 1). Most of Kermanshah Province lies within the Zagros Mountains chain, forming the western periphery of the Iranian Plateau. The Zagros Mountains dominate the province's northern and northeastern areas (Rastegar-Pouyani, 1998). To the west, near the Iranian-Iraqi border, are located the lowlands with elevations of 200–700 m (Rastegar-Pouyani, 1998). Field work was conducted in nine out of fourteen counties in the Kermanshah Province including: Dalahu, Gilan-e Gharb, Harsin, Eslamabad-e Gharb, Kangavar, Kermanshah, Qasr-e Shirin, Sahneh, and Sarpol-e Zahab, due to the presence of potential habitats for *M. h. fasciatus* (see Table 1).

Between October 2013 and November 2014 fieldwork was conducted in the Kermanshah Province with emphasis on the type locality region (Sorkheh Dizeh) (Table 1, and Figures 1 B, 2).

2.2 Methods Dwarf geckos were searched for by lifting stones of various sizes, among leaves underneath oak trees both day and night. Nineteen specimens of *M. h. fasciatus* were collected from four localities (localities 2–4 around the type locality, and locality 6) in western regions and two localities (8–9) in the bordering areas in southeastern regions of Kermanshah Province (for detailed information see Table 1, and Figures 1 B, 2). The collected specimens were fixed in 96% ethanol and were then identified using identification keys (Anderson, 1999; Schmidtler and Schmidtler, 1972). A tissue sample from the tip of intact tail or regenerated portion of the autotomized tail of each specimen was preserved in absolute ethanol for molecular study.

Twenty-six meristic and metric characters were routinely recorded for each specimen as follows: number of supralabials (to the point below the posterior edge of eye, SL); number of infralabials (to the point below the posterior edge of eye, IL), number of postmental pairs (PMP), number of scales separating the first pair of postmentals (at the apex of mental, SSPM), number of scales connected to the first infralabial scale (without numeration of the postmental shield, SCIL), number of scales in a row just below the postmental shields (and between the first pair of infralabial scales, SBIL), number of interorbital scales (the scales on the ridge above the eyes were counted, IOS), number of scales bordering the nostril (SBN), number of scales separating the internasal (supranasal) scales (SSIN), number of subdigital lamellae under the fourth toe (SubL 4th), number of ventral scales from behind the postmentals (at the apex of mental) to level of vent (GVA), number of dorsal scales in midline from axilla to groin (AGS), number of dorsal dark crossbars from forelimbs region to the sacral region (DC), number of tail crossbars (only in intact tails, TC); and metric characters including: snout-vent length (SVL), tail length (only complete original tails, TL), head length (from tip of snout to anterior edge of tympanum, HL), head height (behind eyes, HH), head width (the widest point behind eyes, HW), eye diameter (vertically, ED), distance anterior eye margin to posterior edge of nostril (NED), distance posterior eye margin to ear (EED), interorbital distance (between the ridge above the eyes, IOD), length of forelimb (LFL), length of hindlimb (LHL), distance between forelimb and hind limb (DFH).

Scale counts were taken using a stereomicroscope. Due to the small size of this gecko and the difficulty of

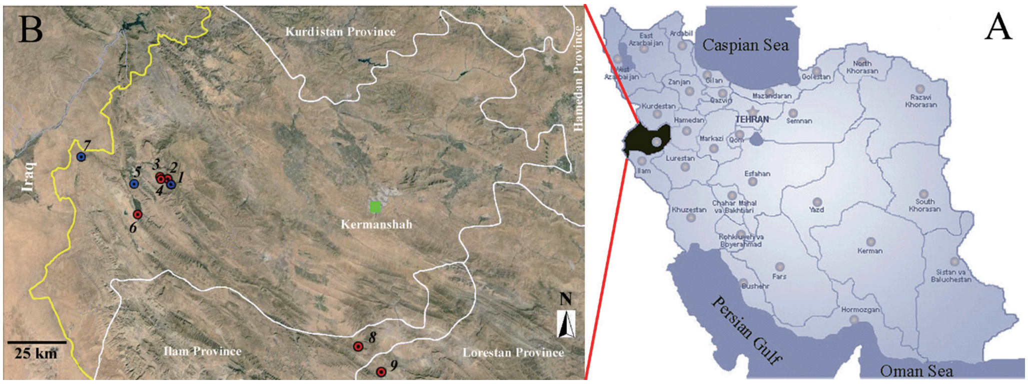

Figure 1 (A) Location of Kermanshah Province on the Iranian Plateau (black marked); (B) Map of Kermanshah Province, showing present (red circles 2–4, 6, 8–9) and previous (blue circle 1 as the type locality (Schmidtler and Schmidtler, 1972), and blue circles 5, 7 (Karamiani and Rastegar-Pouyani, 2012)) collecting sites of *Microgecko helenae fasciatus* in this province. Source for the left map is www.earth.google.com.

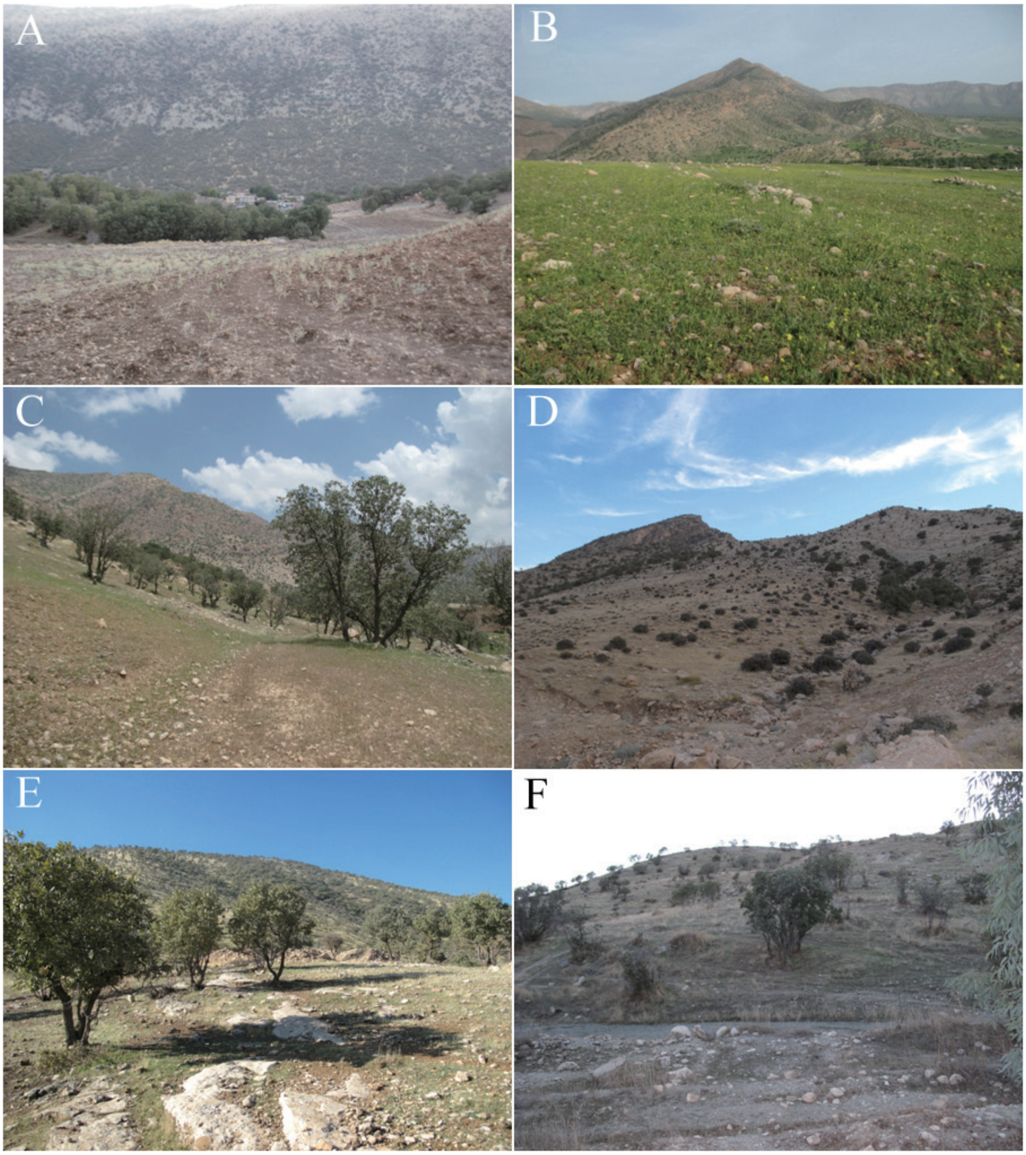

Figure 2 General aspect of six selected habitats of *Microgecko helenae fasciatus* in Kermanshah Province: (A) Sorkheh Dizeh (locality 1, type locality); (B) around Patagh village (locality 4); (C) around Sorkheh Dizeh village (locality 2); (D) around Shelean village (locality 6); (E) around Mela Har village (Locality 8); and (F) around Saymareh Bridge (locality 9). Photos by Ali GHOLAMIFARD.

Table 1 List of previous (1, 5, 7) and present (2–4, 6, 8–9) localities for *M. h. fasciatus* in Kermanshah Province.

Locality No.	Figure No.	Specimen No.	Locality	Coordinate	Habitat description	Date	Author(s)	Remark(s)
1	2A	(*n*=1): ZSM 501/68 (Holotype)	Sorkheh Dizeh village, 25 km to Sarpol-e Zahab and 125 km to Kermanshah, Dalahu County	34°23'57.2"N, 046°03'13.9"E., Alt. 1180 m	Oak forest in the hillside of the Zagros Mountains	23 April 1968	Schmidtler and Schmidtler, 1972	Type locality; surveyed several times without any specimen; destructed via agriculture; exact coordinate by authors
2	2C	(*n*=3): RUZM-GT.11.37–39	About 3 km northwest of Sorkheh Dizeh village, Kermanshah to Sarpol-e Zahab road	34°25'15.36"N, 46°2'0.35"E., Alt. 1187 m	Open oak forest in the hillside of the Zagros Mountains with different species of grasses	13 May 2014	Present study	–
3	–	(*n*=2): RUZM-GT.11.35–36	About 2 km northwest of Patagh village, Sorkheh Dizeh to Sarpol-e Zahab road	34°25'49.5"N, 045°59'37.6"E., Alt. 1016 m	Hillside of the Zagros Mountains with sparse oak trees and varied vegetation	24 April 2014	Present study	Destructed via agriculture
4	2B	(*n*=7): RUZM-GT.11.30–34; RUZM-GT.11.43–44	Around Patagh village, Sorkheh Dizeh to Sarpol-e Zahab road, 15 km to Sarpol-e Zahab	34°25'11.3"–19.3"N, 045°59'57.1"–52.4"E., Alt. 862–876 m	Plain near the hillside of the Zagros Mountains with varied vegetation of occasional grasses and thin cover of low bushes, oak trees in highlands	17, 24 April 2014;10 October 2014	Present study	Surveyed three times; extensively destructed via agriculture and cutting the oak trees
5	–	(*n*=1): RUZM-GT.11.25	Around Sarpol-e Zahab, Sarpol-e Zahab County	34°24'N, 45°52'E	Rocky hills and foothills with sparse annual grasses, thorny bushes and oak trees	No exact time	Karamiani and Rastegar-Pouyani, 2012	Recorded as *Microgecko* (*Tropiocolotes*) *helenae helenae*; approximate coordinate
6	2D	(*n*=3): RUZM-GT.11.40–42	About 3 km southwest of Shelean village, Gilan-e Gharb to Sarpol-e Zahab road, Gilan-e Gharb County	34°16'24.09"N, 45°53'50.07"E., Alt. 797 m	Hillside of the Zagros Mountains with semi sparse cover of oak trees, thorny bushes, and occasional grasses	9 October 2014	Present study	–
7	–	(*n*=4): RUZM-GT.11.21–24	10 km east of Qasr-e Shirin, Qasr-e Shirin County	34°31'N, 45°35'E., Alt. more than 400 m	Rocky hills and foothills with sparse annual grasses, thorny bushes and oak trees	No exact time	Karamiani and Rastegar-Pouyani, 2012	Recorded as *Microgecko* (*Tropiocolotes*) *helenae helenae*; approximate coordinate
8	2E	(*n*=2): RUZM-GT.11.45–46	About 1 km southeast of Mela Har village, Eslamabad-e Gharb to Pol-e Dokhtar road, about 50 km after Eslamabad-e Gharb	33°46'00.5"N, 046°56'59.5"E., Alt. 1389 m	Open oak forest in the hillside of the Zagros Mountains with sparse wild hawthorn trees	5 November 2014	Present study	The locality is within the political boundaries of Kermanshah Province
9	2F	(*n*=2): RUZM-GT.11.47–48	About 1 km southwest of the Saymareh Bridge on the Kermanshah-Pol-e Dokhtar road, border between Kermanshah and Lorestan Provinces	33°40'30.8"N, 047°02'59.4"E., Alt. 897 m	Foothill with semi sparse cover of oak trees, thorny bushes and herbaceous cover, and introduced eucalyptus and olive trees in lowlands	6 November 2014	Present study	The locality is within the political boundaries of Kermanshah Province

measuring fine characters such as eye diameter, especially for specimens with structural artifacts due to fixation, several clear photos were taken from dorsal, ventral and lateral aspects of each specimen using a Canon G10 digital camera. Morphometric characters for each specimen were subsequently measured using Image Tool software (version 3) after calibrating spatial measurement of the software with a scale bar (0.5 mm) of each photo. For preparation of the present distribution map of *M. h. fasciatus* in Kermanshah Province (Figure 1 B), exact or approximate coordinates (those of previous records by Schmidtler and Schmidtler, 1972, and Karamiani and Rastegar-Pouyani, 2012 in localities 1, and 5, 7, respectively) of each locality was inserted in the Google Earth map (earth.google.com). Localities in which the specimens have been collected (present and previous studies) were numbered from 1 to 9 (Figures 1 B, 2; Table 1). Each locality on the map (Figure 1 B) was indexed with the same number in Table 1. Abbreviations and explanations of the recorded collections in this study are as follows: RUZM, Razi University Zoological Museum, Kermanshah, Iran; ZSM, Zoologische Staatssammlung München, Germany.

Table 2 Morphometrics (mm) and meristics of *Microgecko helenae fasciatus* specimens of this study and reexamined meristics of previous specimens (Karamiani and Rastegar-Pouyani, 2012). R: Right; SD: Standard deviation; *: Maximum tail length of four specimens with fully intact tail.

Character	Minimum and Maximum level	Mean±SD
SVL	21.62–37.40	31.26±4.193
*TL	23.48	–
HL	5.06–8.48	7.10±0.996
HH	2.48–4.32	3.61±0.567
HW	3.32–5.94	5.07±0.747
ED	1.12–2.17	1.50±0.313
NED	1.59–2.73	2.21±0.361
EED	2.00–3.45	2.80±0.408
IOD	2.15–5.12	3.72±0.714
LFL	6.05–10.11	7.93±1.13
LHL	9.45–13.51	12.14±1.213
DFH	9.68–17.32	12.71±2.052
SL (R)	6–7	6.24±0.435
IL (R)	5–7	5.40±0.645
SSPM	0–3	1.45±1.02
SCIL (R)	1–3	2.25±0.531
SBIL	9–13	10.91±1.176
IOS	20–30	25.81±2.771
SubL 4th	13–15	14±0.632
GVA	111–127	119.33±4.22
AGS	82–96	89±3.894

3. Results

The main morphometric and meristic characters of the collected specimens in this study and reexamined specimens from a previous study (Karamiani and Rastegar-Pouyani, 2012) are given in Table 2. Present and previous locality records of *M. h. fasciatus* in the Kermanshah Province as well as habitat type of each record are described in Table 1 and shown in Figure 1 B. The list of habitats is based on the latest political divisions of Iran (MIIRI, 2015). General views of several habitats in Kermanshah Province with collection of *M. h. fasciatus* are shown in Figure 2.

3.1 Morphology *Microgecko helenae fasciatus* (Figures 3, 4): A small gecko (Figure 3), snout-vent length 21.62–37.40 mm (19 specimens), with smooth, homogenous, juxtaposed dorsal scales, 82–96 along midline between axilla and groin; nostril bordered by 5 scales (rostral, first upper labial, supranasal [internasal], and two smaller nasals) (Figure 4 A); supranasals enlarged, in contact (60%) or separated by one (16%), two (16%), or three (8%) scales, followed by a pair of large postsupranasals, separated from each other by two scales, that are twice as large as succeeding scales (Figure 4 A); rostral pentagonal, about three-quarters cleft by a distinct, vertical groove (Figure 4 A); pupil vertical; supralabials 6–7, usually 6; infralabials 5–7, usually 5 (Figure 4 B); mental nearly trihedral, followed by two large postmentals, which are in contact (25%) or separated by one (16.7%), two (45.8%), or three (12.5%) gular scales at apex of mental (Figure 4 C, D); dorsum brownish gray in life, with five dark crossbars about two to three scale rows wide, narrower than interspaces, the first between forelimbs and the last on sacral region, each followed by a equally or a much wider whitish crossbar (Figure 3); laterally, a dark brown bar on either side from rostral passing through eye to ear, where it may end, or continuing onto shoulder (Figures 3, 4 A, B); venter white, unpatterned (Figure 4 F); ventral scales smooth, homogeneous, larger than dorsals (Figure 4 F); digits not dilated, compressed, clawed, with slight angular bend (Figure 4 E); subdigital lamellae smooth, 13–15 under fourth toe (Figure 4 E); scales of tail smooth, homogeneous, imbricate, larger than dorsals, subequal dorsally and ventrally; tail thick and fragile; dorsal pattern always present on intact tail, consisting of 7–9 transverse straight or slightly undulating dark brown bands narrower than interspaces, each followed by a yellowish-white to dark yellow crossbar from front to back (Figure 3); regenerated portion of tail without bars from yellowish to light brown up to black, dorsally and ventrally (Figure 3 A); no distinct sexual dimorphism, males lacking preanal

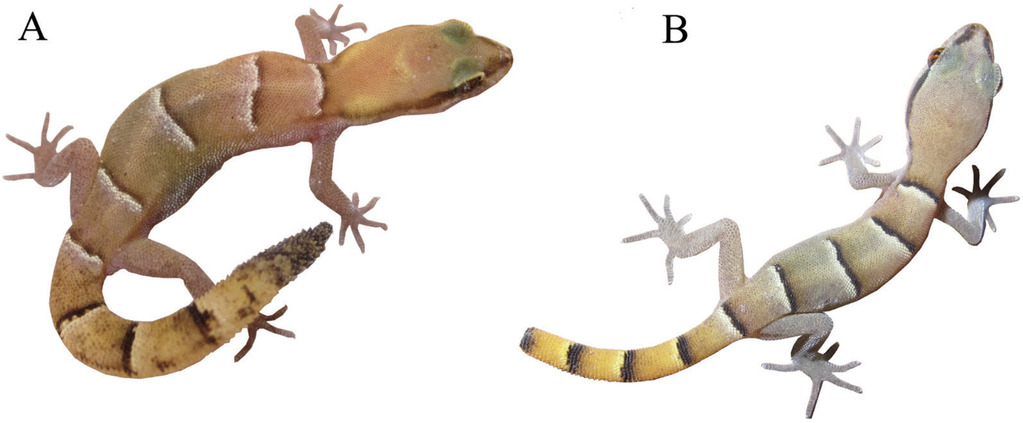

Figure 3 *Microgecko helenae fasciatus*: (A) an adult female in wild (RUZM-GT.11.34; SVL: 32.31 mm) with regenerated tail; (B) a juvenile (RUZM-GT.11.43; SVL: 26.58 mm) in captivity with broken tail, both from locality 4 in April and October 2014, respectively. Photos by Ali GHOLAMIFARD.

pores; a pair of entrances to the postcloacal sacs on basal-ventral part of the tail (Figure 4 F).

3.2 Habitat All of the present and previous specimens of *M. h. fasciatus* (Karamiani and Rastegar-Pouyani, 2012; Schmidtler and Schmidtler, 1972; Torki, 2007) were collected from habitats with presence of oak trees at an elevational range of about 500–1500 meters above sea level (Table 1). With the exception of one collection site (locality 4) where oak trees are rare (Figure 2 B), oak trees are dominant at other localities of *M. h. fasciatus* in this study (Table 1) (Figure 2 C–F). Based on field observations, destruction of natural habitat via increased agricultural use by humans (Figure 2 A, B) is the main reason for the lack of oak trees in the small scale habitat of this tiny gecko (about one kilometer from collection point to the nearest oak trees) near the village of Patagh (locality 4) (Figure 2 B).

4. Discussion

Based on Bauer *et al*. (2013) the genus *Microgecko* is resurrected for populations of the dwarf geckos in Iran, Pakistan, and India (Rajasthan in the northwest of India), although a careful revision of the dwarf geckos in Iran is still needed. *Microgecko helenae* is distinguished from its congeners by having a single pair of postmentals and six to seven supralabials (Leviton and Anderson, 1972; Minton *et al*., 1970; Szczerbak and Golubev, 1996). In the subspecies *helenae* unlike *fasciatus* the postmental shields are not in contact with each other (Anderson, 1999) and the number of dorsal scales between axilla and groin (AGS) in *M. h. helenae* is 65–84 while in *M. h. fasciatus* is 80–92 (Anderson, 1999; Leviton *et al*. 1992; Schmidtler and Schmidtler, 1972), but up to 96 according to our new data. According to Schmidtler and Schmidtler (1972), *M. h. fasciatus* is especially characterized by its five dark and clear transverse bars on back, and 80–92 dorsal scales between axilla and groin. The specimens recorded by Karamiani and Rastegar-Pouyani (2012) from Kermanshah Province (localities 5, 7) regarded as *M. h. helenae* (formerly *T. h. helenae*) were reexamined (Table 2), and exhibit the diagnostic characters of *M. h. fasciatus*. This diagnosis may have been due to Karamiani and Rastegar-Pouyani (2012) having referred to Anderson (1999: 192–193) where he gave the nature of postmental shield contact and the range of dorsal scales between axilla and groin as diagnostic characters for the separation of *M. helenae* subspecies. In our specimens, as well as in previous specimens (Karamiani and Rastegar-Pouyani, 2012), the connection of the postmental shields is variable, as in most cases the postmental shields are fully separated from each other (Table 2; Figure 4 C). Also, with reexamination of the AGS character of the previous specimens, counts in the midline of the dorsum between axilla and groin, not along the lateral aspect of body are consistent with *fasciatus* (Table 2). Two additional collections of *M. h. helenae* from Ilam (Darreh Shahr) and Lorestan (Pol-e Dokhtar) Provinces cited by Karamiani and Rastegar-Pouyani (2012) should also be considered as *M. h. fasciatus*. Thus, this gecko is well distributed on the western slopes of the Zagros Mountains in Kermanshah, Lorestan and Ilam Provinces.

The color of the regenerated portion of tail in different specimens varied from yellowish to light brown up to black in life (Figure 3 A). Most likely this color change occurs over time, and probably in the absence of intact tail has some ecological functions. The black regenerated portion of tail has also been recorded in *M. h. helenae*

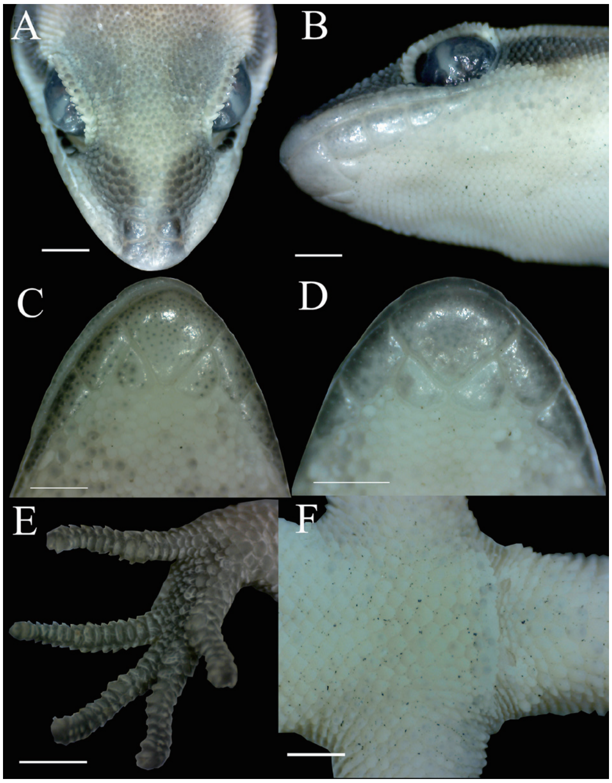

Figure 4 *Microgecko helenae fasciatus*: (A) Dorsal view of head; (B) ventrolateral view of head; (C, D) ventral view of head showing position of the postmental shields and their contact manner; (E) ventral view of toes; (F) ventral view of cloacal region. Scale bar = 1 mm. Photos by Ali GHOLAMIFARD.

(Minton *et al.*, 1970; Tuck, 1971). According to our findings on the habitat structure of this tiny gecko and those of previous studies (Karamiani and Rastegar-Pouyani, 2012; Schmidtler and Schmidtler, 1972; Torki, 2007), there is a significant relationship between presence of this gecko and oak trees. In habitats of *M. h. fasciatus* the climate is cooler and wetter than that in which *M. h. helenae* is found (Anderson, 1999). Open oak forest characterizes habitats of *M. h. fasciatus* in Kermanshah, Lorestan (Schmidtler and Schmidtler, 1972) and Ilam Provinces, but elevation and temperature are also affecting the presence of this gecko in habitat. Also, the gecko prefers habitats with suitable soil, a good proportion of soil and stone for its ecological requirements such as shelter, not rocky or stoneless habitats. Although a number of more or less detailed publications providing distributional and taxonomic data on Iranian dwarf geckos (see above), there are still questions concerning the distribution and taxonomy of these dwarf geckos in Iran that are to be resolved. Finally we recommend molecular studies, as well as behavioral and ecological studies, to understand the taxonomy and phylogeny of these lovely geckos in Iran.

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